Experimental evidences for anomalous grain boundary diffusion of Fe in Cu and Cu-Fe alloys

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Grain boundary diffusion in the Cu-Fe system is still an issue despite a well-developed methodology of grain boundary diffusion measurements. Rare results obtained for this system by different authors have been published so far [1-4] and they are contradictory to some extent.

The aim of the present study is to complete the published previously measurements and to clarify the specific behaviour of Fe in Cu. Fe grain boundary diffusion is studied in 99.995 wt.% pure Cu and the Cu-Fe alloys with iron contents of 0.18, 0.45, 0.6 and 0.8 wt. % using the radiotracer technique. A series of isothermal experiments at 1000 K reveals that the triple product of iron grain boundary diffusion is almost independent on the iron content excepting the alloy containing 0.8 wt. % of Fe where the triple product is increased by three orders of magnitude. Additional experiments at 1100, 900 and 717 K using this alloy confirm the anomaly observed at 1000 K, namely the triple product is continuously increasing following the Arrhenius dependence from 717 K to 1100 K except the temperature of 1000 K, where the triple product is anomalously high.

The obtained results are analyzed applying thermodynamic calculations of Fe and S solubility in Cu. It is suggested that the observed anomalies are related to a change of the grain boundary structure associated with a phase transition occurring in the Cu-Fe alloys.

References

[1] J. Bernardini, C. Girardeaux, A. Rolland, Def. and Dif. Forum 249 (2006) 161-166.
[2] J. Ribbe, G. Schmitz, S.V. Divinski, Def. and Dif. Forum 289-292 (2009) 211-217.
[3] D. Prokoshkina, A. Rodin, V. Esin, Def. and Dif. Forum 323-325 (2012) 171-176.
[4] J. Ribbe, Diploma work, University of Münster, Germany (2006).